NEUROVASCULAR RELATIONSHIPS IN THE WALL OF THE STOMACH DURING INTERFERENCE WITH THE PORTAL BLOOD FLOW

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The present paper is devoted to a description of the neurovascular relationships in the wall of the stomach during interference with the blood flow in the portal venous system in man (in cirrhosis of the liver) and during ligation of the portal vein in animals. It is the sequel to our earlier research in this direction [16].

EXPERIMENTAL METHOD

In order to study the neurovascular relationships in the wall of the stomach material was utilized from the cadavers* of 5 persons dying from cirrhosis of the liver and from 20 animals (cats and dogs) after ligation of the portal vein. The animals survived for one to eight months after the experiment. We used the fundus and the pyloric division of the stomach for the investigation. The specimens were treated mainly by the Bielschowsky-Gros method, with counterstaining of the vessels with acid fuchsin; Ranson's and Nissl's methods were also used.

The nervous apparatus of the stomach, especially in animals [12], is impregnated with great difficulty. Despite the use of various methods of fixing and staining the material, we did not succeed in obtaining a clear picture of the nerve plexuses of the cat's stomach by means of the Bielschowsky-Gros and Ranson methods. We were able to see only nerve trunks with regenerating fibers and cells of a round shape and devoid of processes.

The nervous apparatus of the dog's stomach impregnates poorly but more completely, we obtained the best results from staining the human stomach.

EXPERIMENTAL RESULTS

During examination of histological preparations of the above-mentioned portions of the stomach from man and animals, the first to be observed is the severe dilatation of the capillaries, the density of the vascular network and the presence of blood cells in the surrounding tissues.

The neurovascular relationships which we found are as follows. In the first place, very often and mainly in preparations from the human stomach, dendrites of nerve cells – particularly of Auerbach's plexus – with bulbs (or spherical thickenings) at their ends are situated on adjacent vessels (Fig. 1). Sometimes the majority of dendrites of a cell are included in a connection of this sort. In the second place it is often possible to see synaptic endings of fine fibrils situated on the walls of vessels (Fig. 2). These endings are of the most varied shapes and sizes. The presynaptic fibers have either quite even contours or, more often, they are uneven and contain pools of neuroplasm along their course. Finally it may also be possible to seen the picture of a nerve fiber, at the point of its intersection of a capillary, giving off lateral processes shaped like rockets of irregular disks (Fig. 3). The latter form of neurovascular relationships was mainly observed in dogs.

* The postmortem material was placed at our disposal by D. S. Sarkisov (of S. S. Vail's laboratory) and the Department of Pathologic Anatomy of the S. M. Kirov Order of Lenin Military Medical Academy.

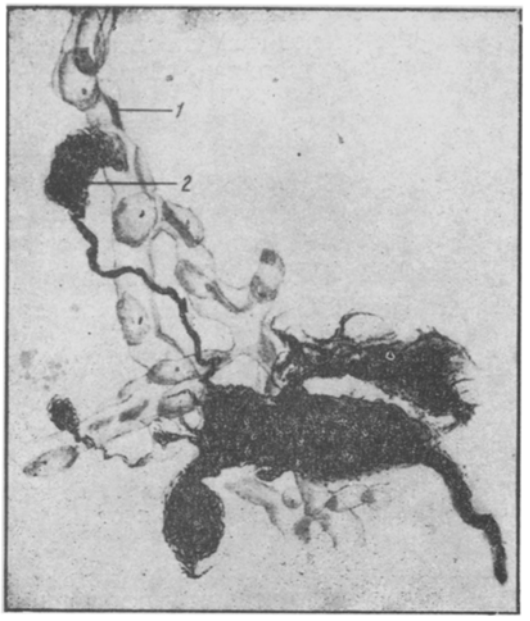

Fig. 1. Intermuscular nerve plexus in the human stomach. Connections of the dendrites of nerve cells with capillaries.
1) Capillary; 2) dendrite with "pin-head" at the end. Stained by the Bielschowsky-Gros method. Magnification: ocular 15×, objective 90×.

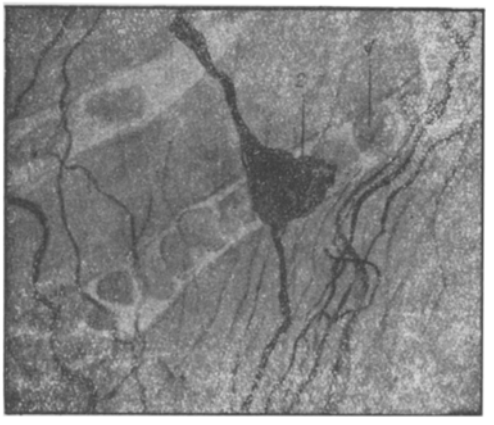

Fig. 3. Intermuscular nerve plexus of the stomach of the dog. A lateral process of the nerve fiber at its point of intersection with a capillary.
1) Capillary; 2) lateral process of the nerve fiber. Stained by the Bielschowsky-Gros method. Magnification: ocular 15 ×, objective 90 ×.

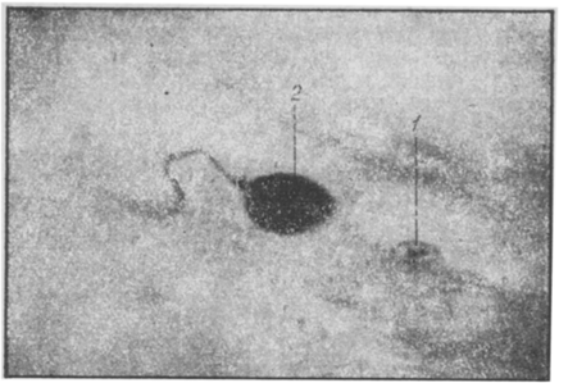

Fig. 2. Intermuscular nerve plexus in the stomach in man. A synaptic ending on a vessel.
1) Vessel; 2) synaptic ending. Stained by the Bielschowsky-Gros method. Magnification: ocular 10 ×, objective 90 ×.

Connections between dendrites and vessels were previously described in the central nervous system by Golgi [17], who postulated that it was through these connections that the nutrition of the parenchyma of the brain is effected. This view was supported by a number of workers, but later on M. D. Lavdovskii [13] and others categorically denied that connections could exist between dendrites and capillaries, believing that they could occur only in the glial cells.

Dendrites are usually regarded as a means for the enlargement of the receptive surface of the neuron and for increasing its area of contact with the axon of the adjacent neuron which forms pericellular structures at this point. In recent years some neurohistologists have begun to regard the role of the dendrites as being wider [12].

Z. N. Khoros [15], investigating neurones in ganglia in the vermiform appendix and ileocaecal region in man, the rabbit and the cat, found that one cell may give off processes whose endings lie on the most varied structures, including vessels. On these grounds this worker considers that the dendrites of the nerve cell have different physiological characteristics.

On the subject of the physiological role of dendrites terminating on vessel walls, it may be supposed that neurovascular connections of this type are of importance in the performance and regulation of metabolic processes, especially in pathologic conditions such as cirrhosis of the liver when considerable biochemical changes take place in the composition of the blood.

These problems may be finally solved by means of histochemical methods of investigation. So far as the second and third types of neurovascular connections are concerned, the first question which arises here is the nature of these nerve endings on the vessels, i.e. it has to be determined from what fibers they are formed – preganglionic or postganglionic.

From his extensive observations on axonal synapses on vessels in the central nervous system, B. A. Dolgo-Saburov [6] considers that they are conductive in origin, i.e. of the same nature as the synapses observed on the dendrites and bodies of nerve cells. A. S. Gusev's preliminary experimental findings confirm this hypothesis.

The synapses which we found on the vessels of the stomach are evidently formed from preganglionic fibers of the vagus nerve. This assumption is confirmed by the presence of synapses on the Dogiel type one cells in the wall of the stomach and duodenum and their absence from the middle portion of the small intestine. Here we found only connections between dendrites and vessels [16] and not once did we see synapses on capillaries like those described above. It is natural to think that the synapses found on the Dogiel type one cells and on the vessels of the stomach have a common origin. The detailed analysis of this question will be the subject of our research in the future.

The synapses on the vessels of the stomach are evidently present in normal conditions too, but pathological processes cause them to undergo reactive changes, leading to argyrophilia, and thereby making them more readily demonstrable.

D. Iu. Guseinov and S. Rustambekov [3] investigated the nervous apparatus of the stomach and described ramifications of nonmedullated fibers on the capillaries, forming retiform sheaths with large number of thickenings and "boutons terminaux." In the wall of an arteriole also they found a nerve end-plate (in the opinion of these authors it was probably receptor) closely connected with its cells.

N. N. Zhuravlev [7], who studied the nervous appartus of the stomach in man in carcinoma, saw that where they intersect with the capillaries, nerve fibers form varicose thickenings much larger than those usually seen along the nerves.

If the illustrations in certain papers on the pathomorphology of the vegetative nervous system [2, 8] are examined, nerve endings may be observed on vessels; the authors did not, however, give this feature its due recognition.

There is no unanimity in the literature on whether the nervous system in the different divisions of the gastrointestinal tract, for example the stomach and the small intestine, is equally vulnerable. S. S. Vail' [1], who investigated the nervous apparatus of the stomach and intestines in tuberculosis, came to the conclusion that in comparison with the ganglia of the small and large intestines, the nervous apparatus of the stomach is particularly vulnerable. On the other hand, N. G. Kolosov [11] is of the opinion that the nervous apparatus of the intestine is most delicate and vulnerable.

In our investigations of the ganglia of the wall of the stomach and ileum in man and experimental animals we found the most varied and pronounced changes in the nerve cells in the ileum. Such features were found less often when we studied the nervous apparatus of the stomach wall; when they were observed there it was only in the submucosal plexus and Auerbach's plexus in the pyloric region. We usually found changes in the nerve structures in places where the cells were mainly of Dogiel's second type; in our opinion they are less resistant to any form of change in the internal environment of the body.

Our findings are in contrast to those of certain workers [9, 10 and other] who consider that cells of Dogiel's first type undergo the greatest changes during pathological conditions. The same opinion is held by N. G. Kolosov [11], who explains the great vulnerability of Dogiel's type one cells by their greater differentiation.

If we agree with N. G. Kolosov, however, it is difficult to account for the fact that in the same pathological condition (cirrhosis of the liver) almost half the ganglion cells in the intermuscular plexus of the small intestine (not to metnion the submucosal plexus) are severely affected, whereas in the stomach these changes are only slight.

SUMMARY

The author examined the intestinal wall in 5 cadavers of patients deceased from cirrhosis and in 20 animals (cats and dogs) after the ligature of their portal veins. Tissues were treated by Bielschowsky-Gros method with an additional staining of the blood vessels by acid fuchsin. Intimate neurovascular relations were revealed in the liver both in human cirrhosis and in experimental animals (dogs) after the ligature of the portal vein. These relations were represented by the presence of terminations of dendritis of the ganglionic cells on capillaries. Large numbers of synaptic endings of thin fibers (of various length) were also found on the blood vessels.

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